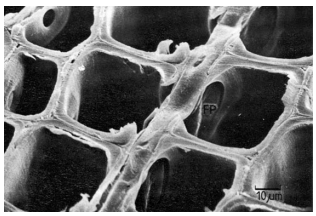
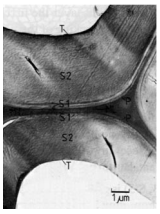
CELL WALL CROSS-LINKING: Its Impact on Digestibility

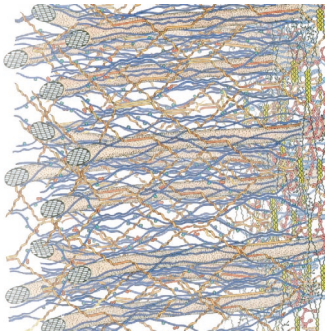


Electron-micrographs of plant cell walls.

The plant cell wall is beautifully engineered for strength and flexibility.

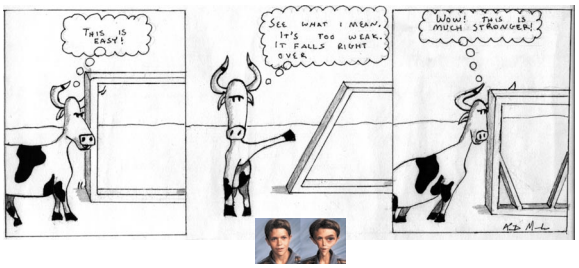


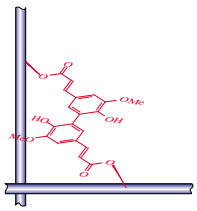
Part of the strength comes from cross-linking the various components of the cell wall matrix...



...just as a braced object is much stronger.

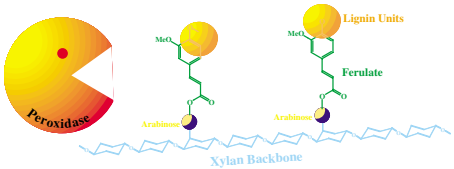
A square structure is a pushover for a cow. If that structure is braced ("cross-linked") it becomes much stronger. Cartoon by Andy Muenchow at 13.



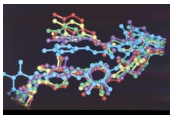


Cell wall polysaccharides are cross-braced in a similar way. As a result, digestibility by the cow is no longer a pushover either.

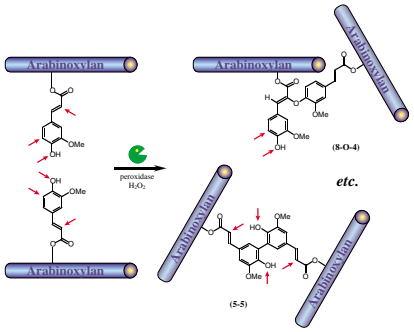
In grasses, "ferulates" act as cross-linking agents, tying polysaccharides to each other and to lignin.



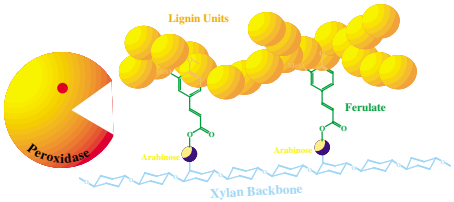
Lignin (orange sphere) starts to attach to ferulates (green) on the polysaccharide backbone.



Ferulate on polysaccharide



Ferulates cross-link two polysaccharides by "dimerizing".



Lignin (orange spheres) growing from the ferulates (green) on the polysaccharide backbone. Now the polysaccharide is harder to access by enzymes -- i.e. the polysaccharide becomes protected from digestion.

But...

Ruminants get their energy from digesting polysaccharides.

The enzymes that do the digestion can be big (on a molecular scale), so linking polysaccharides to each other or to the lignin inhibits access to the yummy polysaccharides.

Result: Cross-linking is useful for the plant but a pain for its efficient utilization (by ruminants).

What can we do about cross-linking?

We are currently working to determine if cross-linking can be decreased (and to what level) without harming plant productivity.

Some cross-links can be broken by fungal, enzymatic, or chemical treatments to improve digestibility.